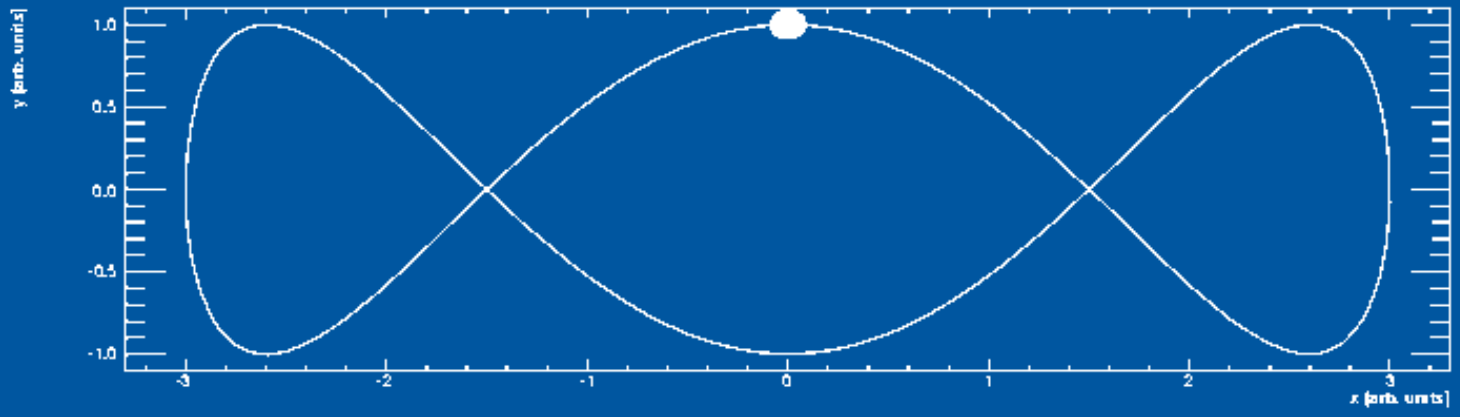
AARHUS UNIVERSITET

EUROPEAN SPALLATION SOURCE

January 25, 2013

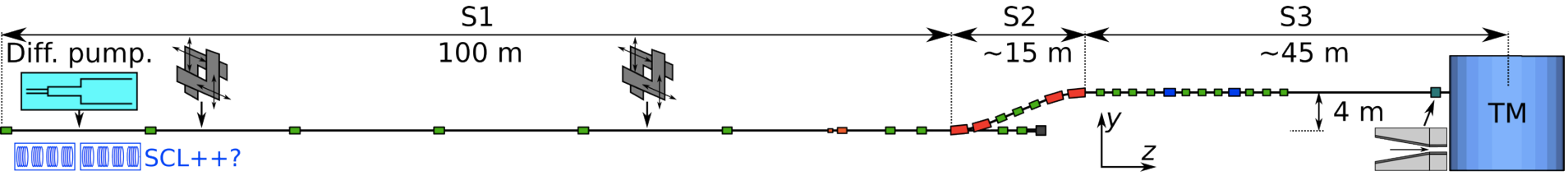
Raster Scanning of the ESS Beam

Heine Dølrath Thomsen



The HEBT (28.05 2012)

Dipoles,
Quadrupoles
Octupoles



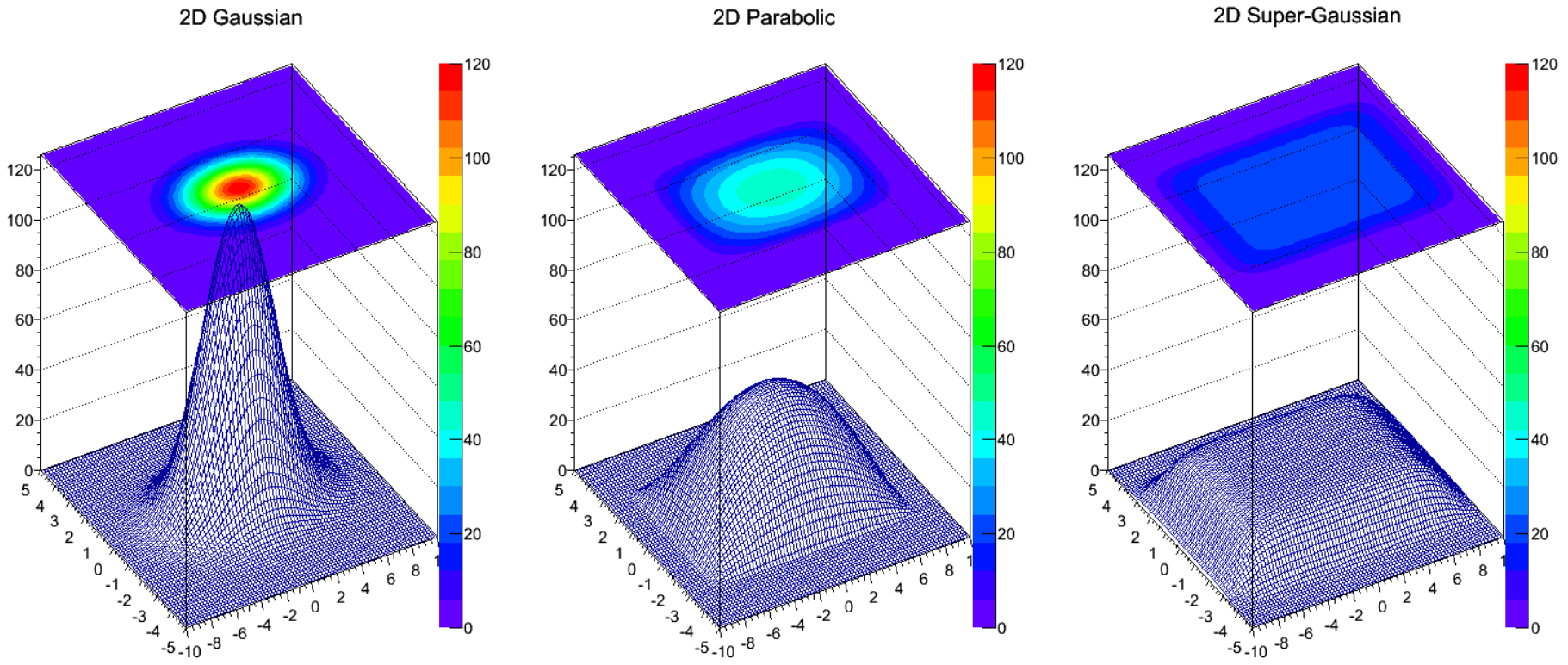
› UHB: Energy upgrade + movable collimators.

› ACH: Achromatic elevation. Tune-up lines below.

› A2T: Beam expander system (non-linear) + fixed collimator.

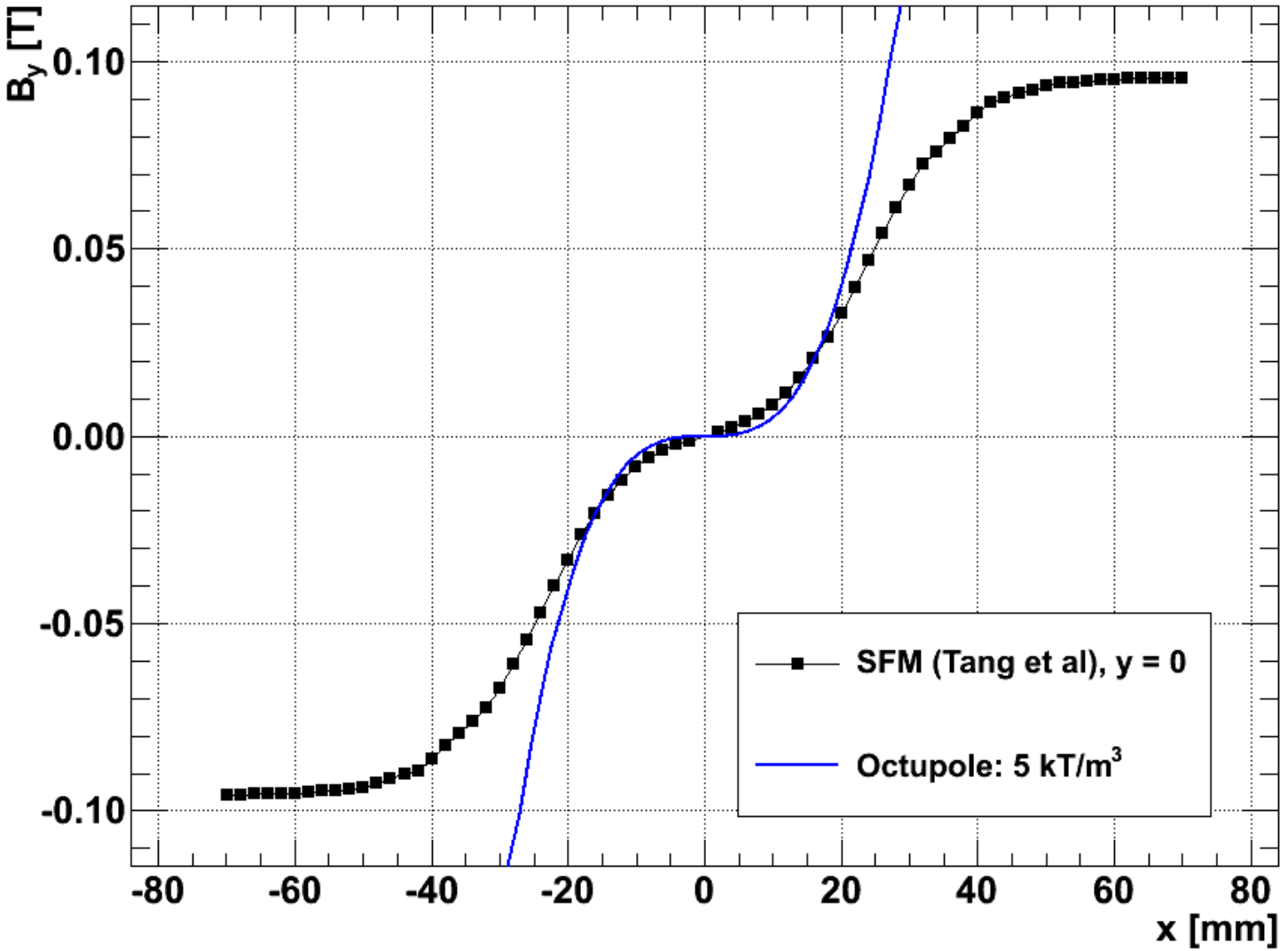
Exploiting the target footprint area!

J [μA/cm^2]



Lowering the max. current density J => increasing target life!

Be

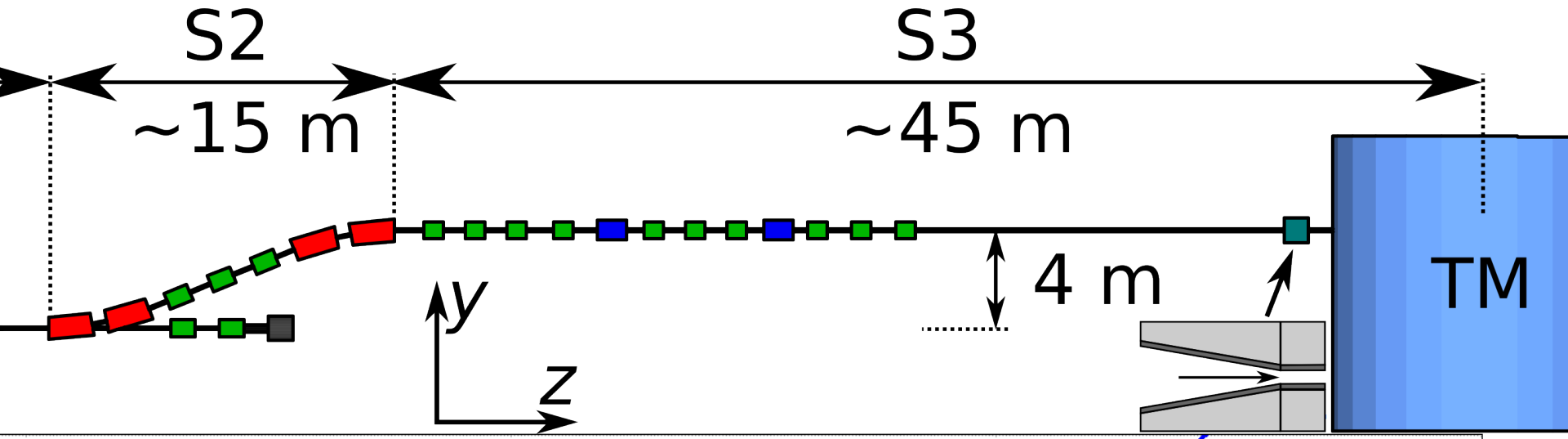


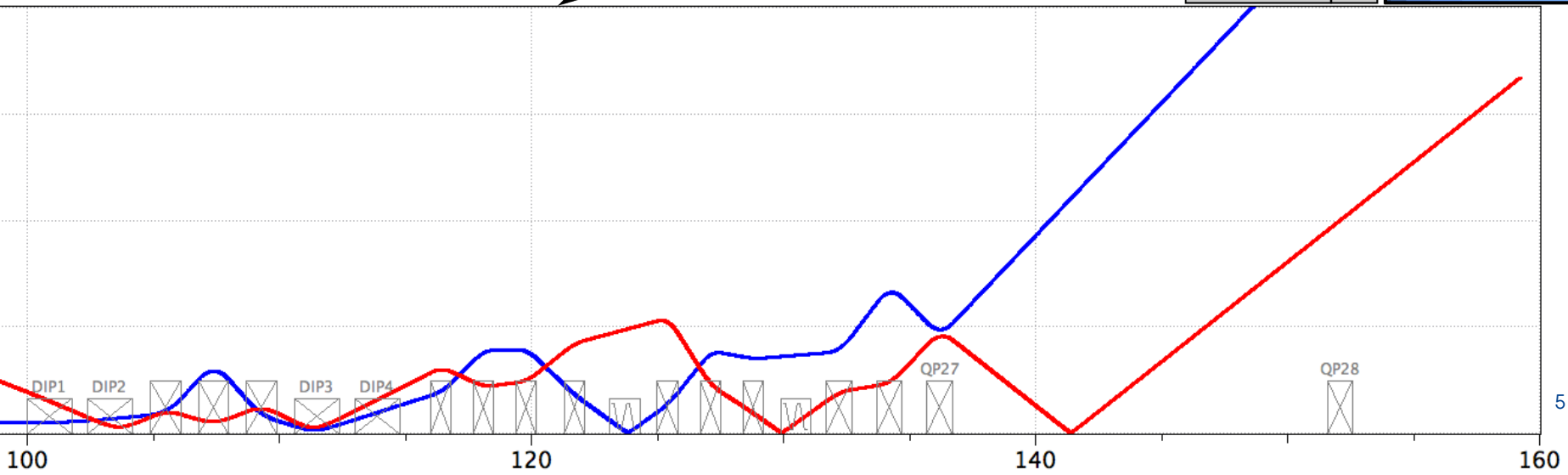
ESS2003-LP

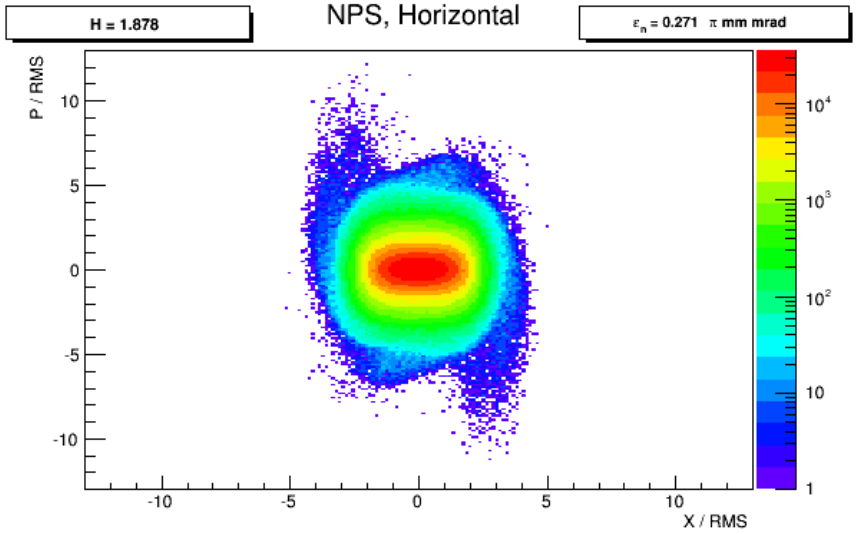
ESS2003-SP, CSNS, IFMIF

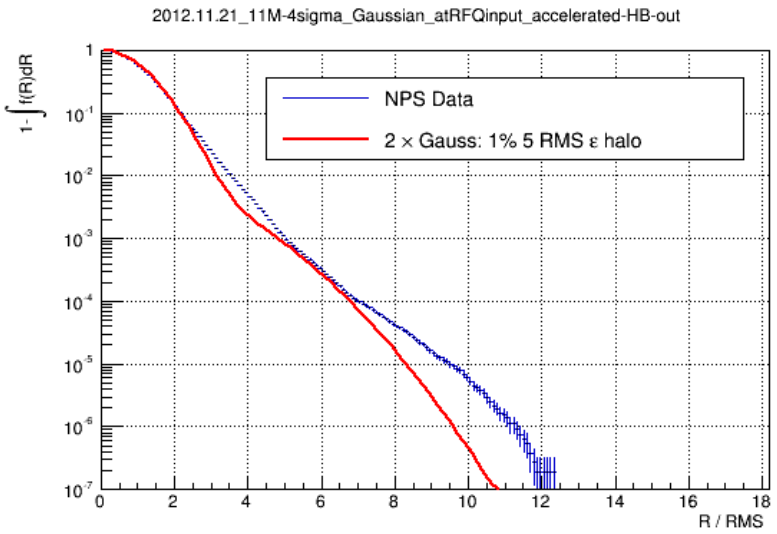
The HEBT (28.05 2012)

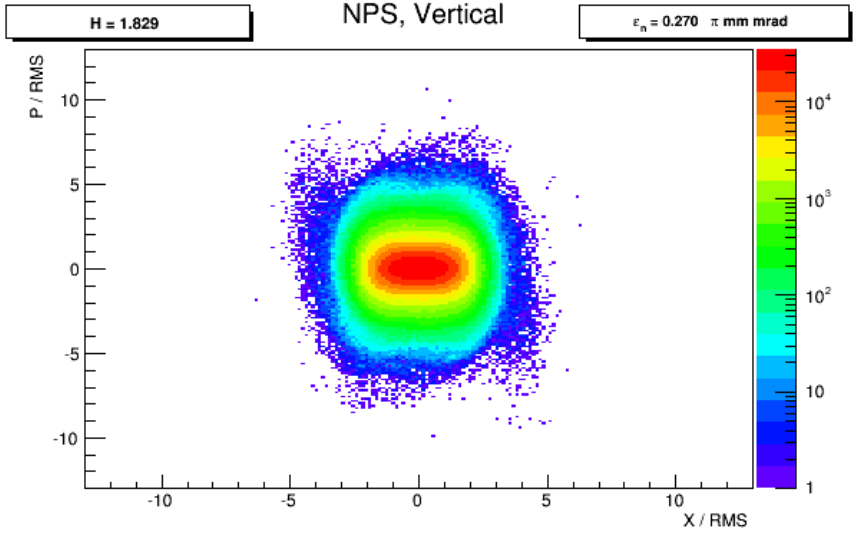
Dipoles,
Quadrupoles
Octupoles

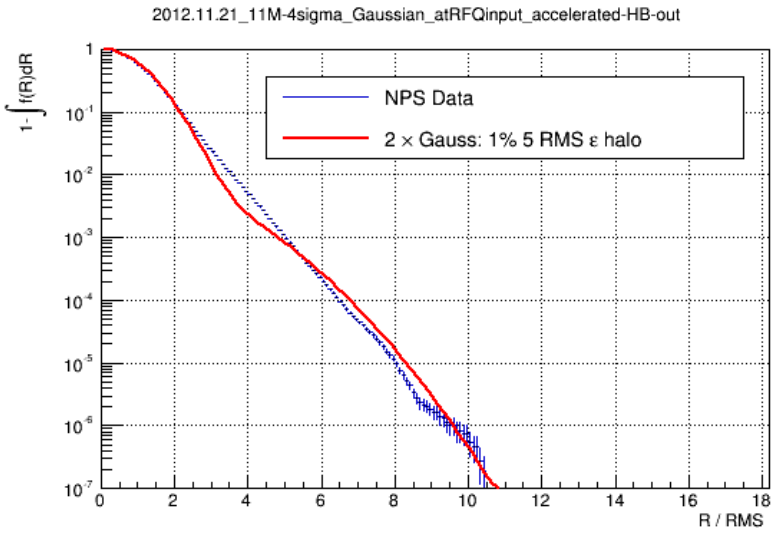




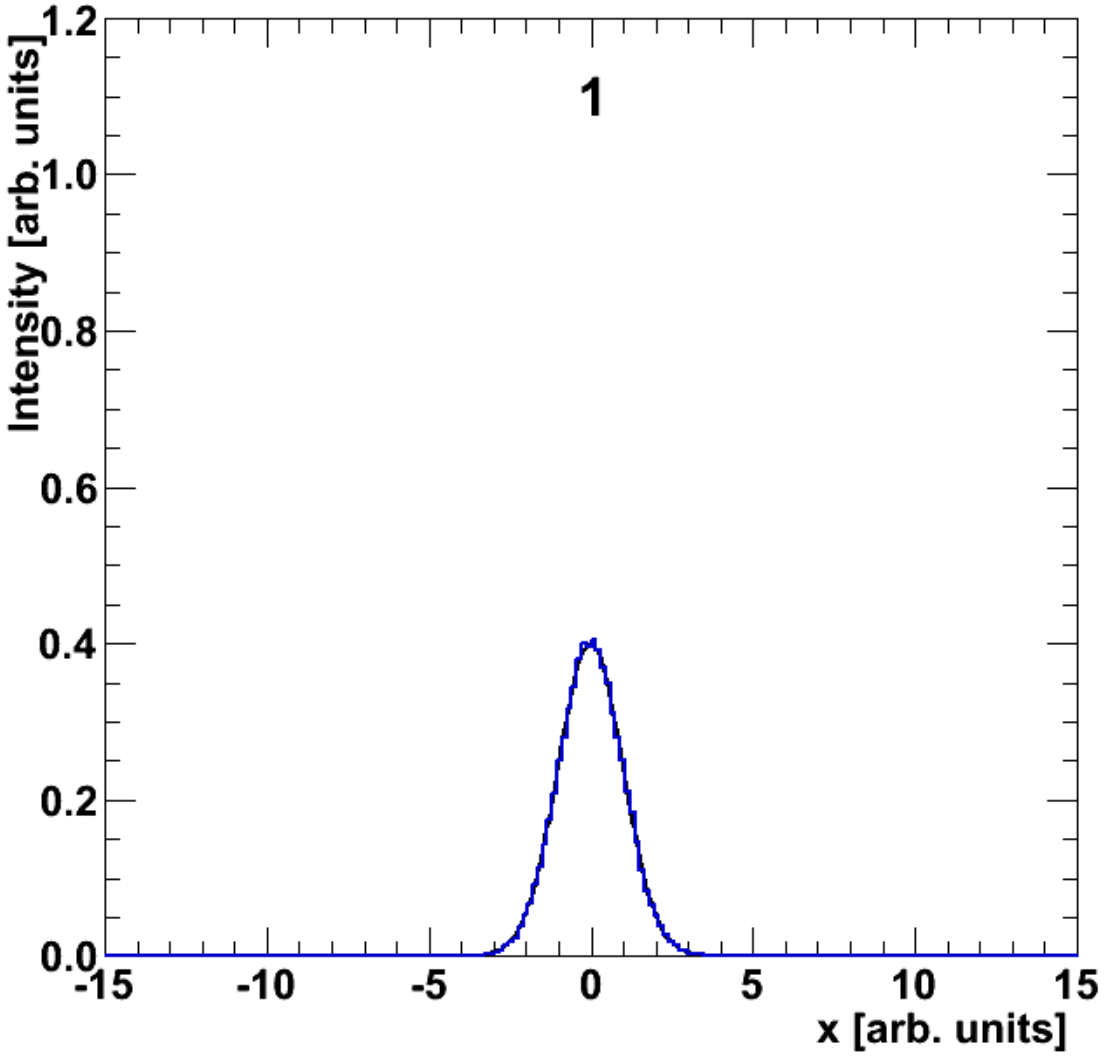

H = 1.878
NPS, Horizontal
ε_n = 0.271 π mm mrad
P / RMS
X / RMS


2012.11.21_11M-4sigma_Gaussian_atRFQinput_accelerated-HB-out
NPS Data
2 × Gauss: 1% 5 RMS ε halo
1- ∫ f(R)dR
R / RMS

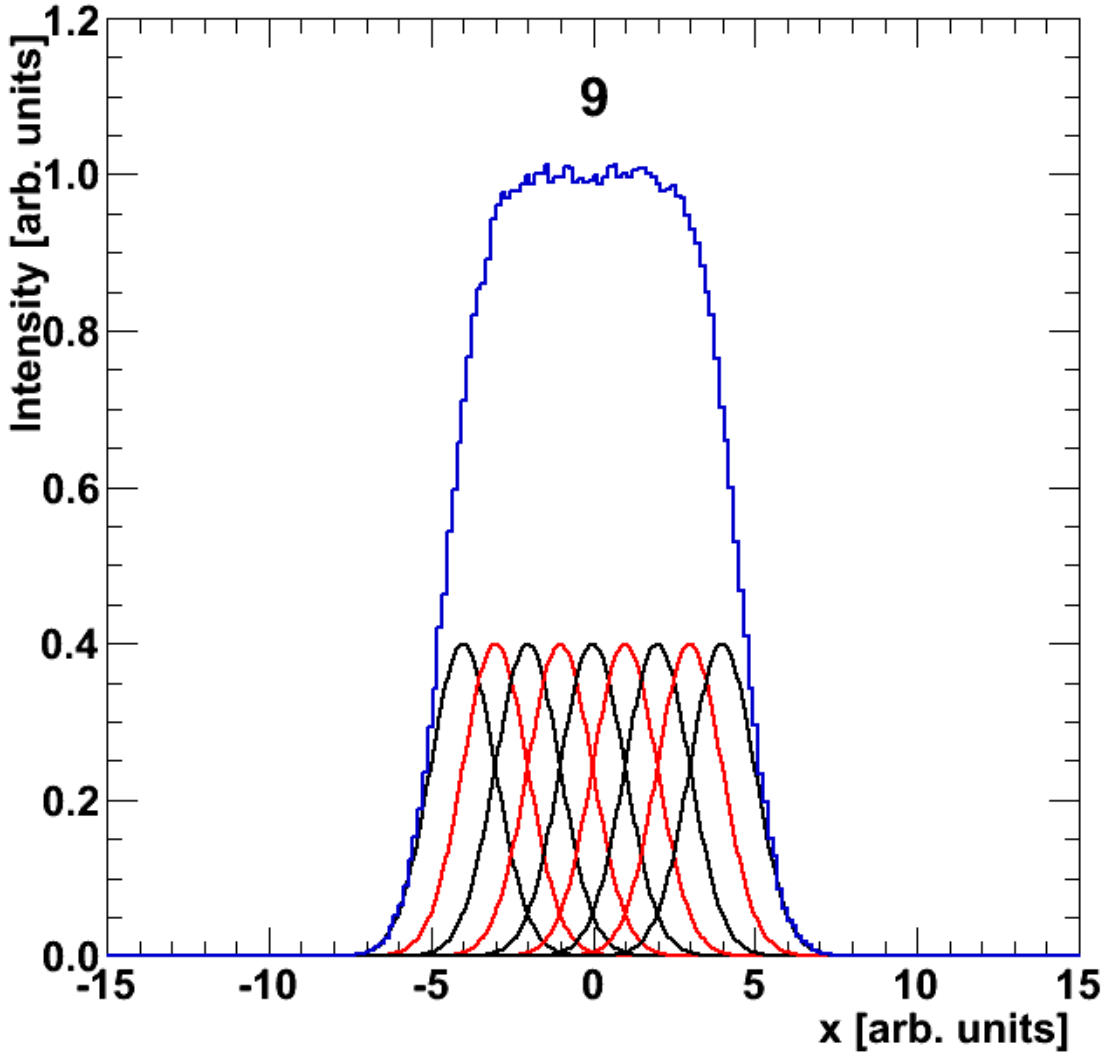

H = 1.829
NPS, Vertical
ε_n = 0.270 π mm mrad
P / RMS
X / RMS


2012.11.21_11M-4sigma_Gaussian_atRFQinput_accelerated-HB-out
NPS Data
2 × Gauss: 1% 5 RMS ε halo
1- ∫ f(R)dR
R / RMS

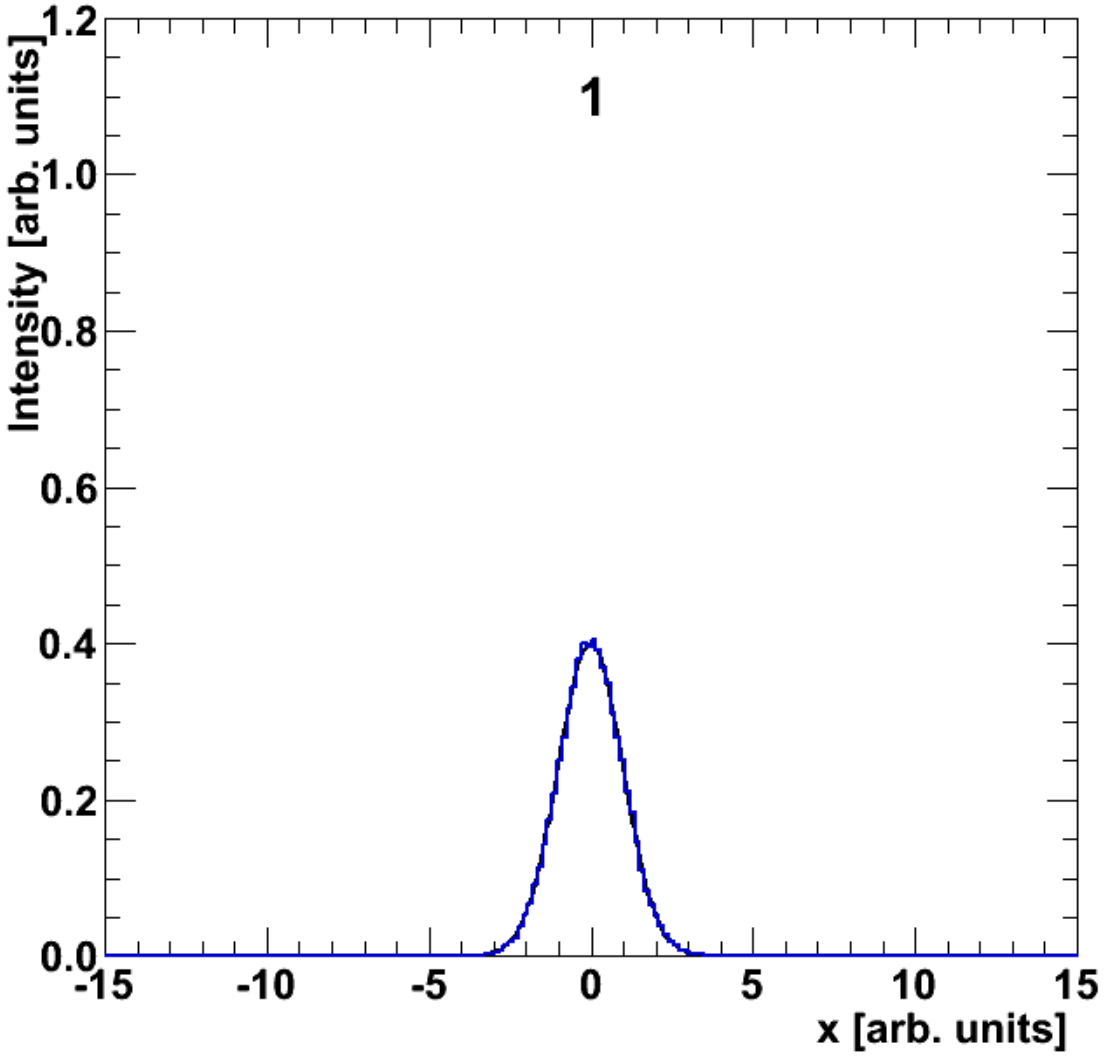
Beam Expander Systems II: 1D Rastering



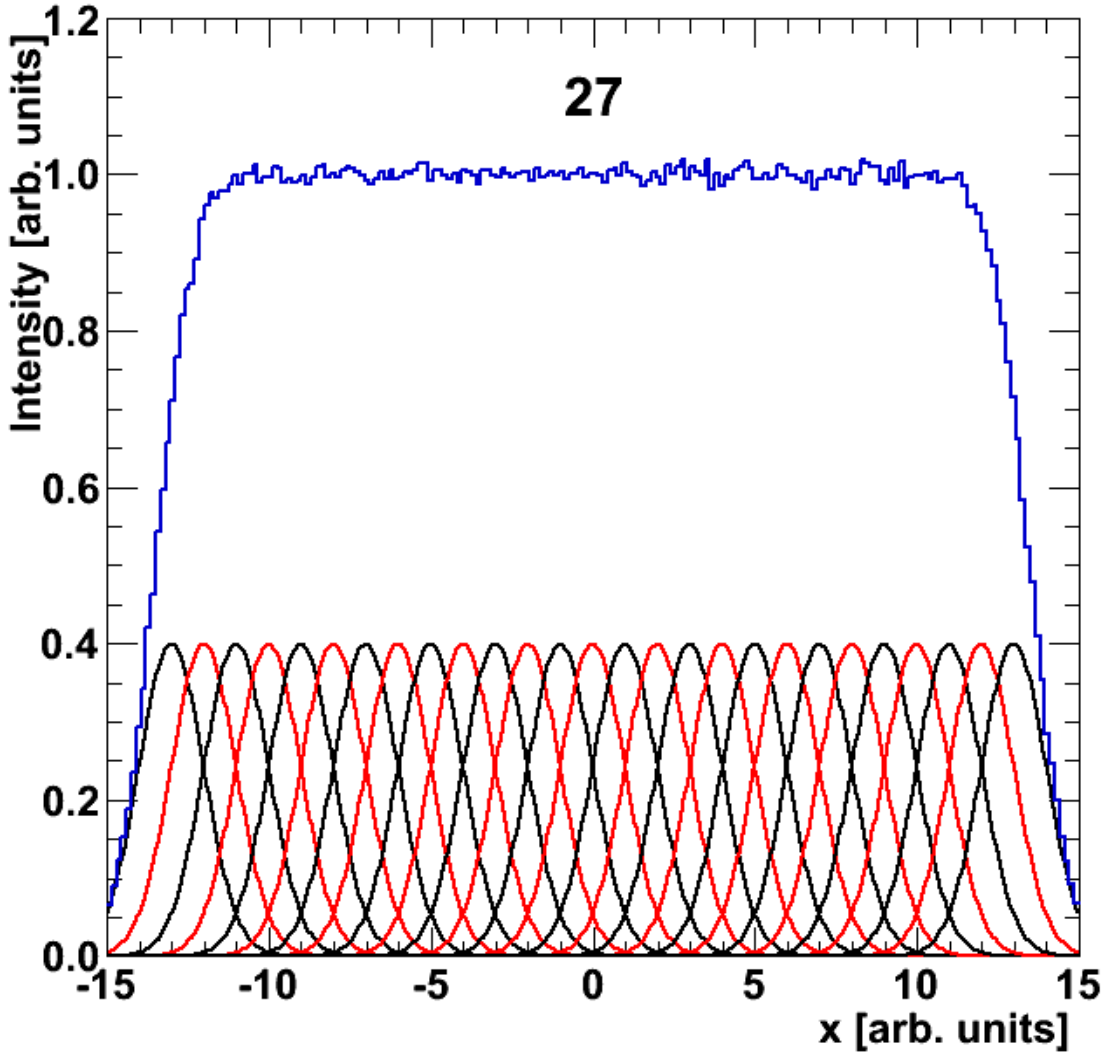
Beam Expander Systems II: 1D Rastering



Beam Expander Systems II: 1D Rastering

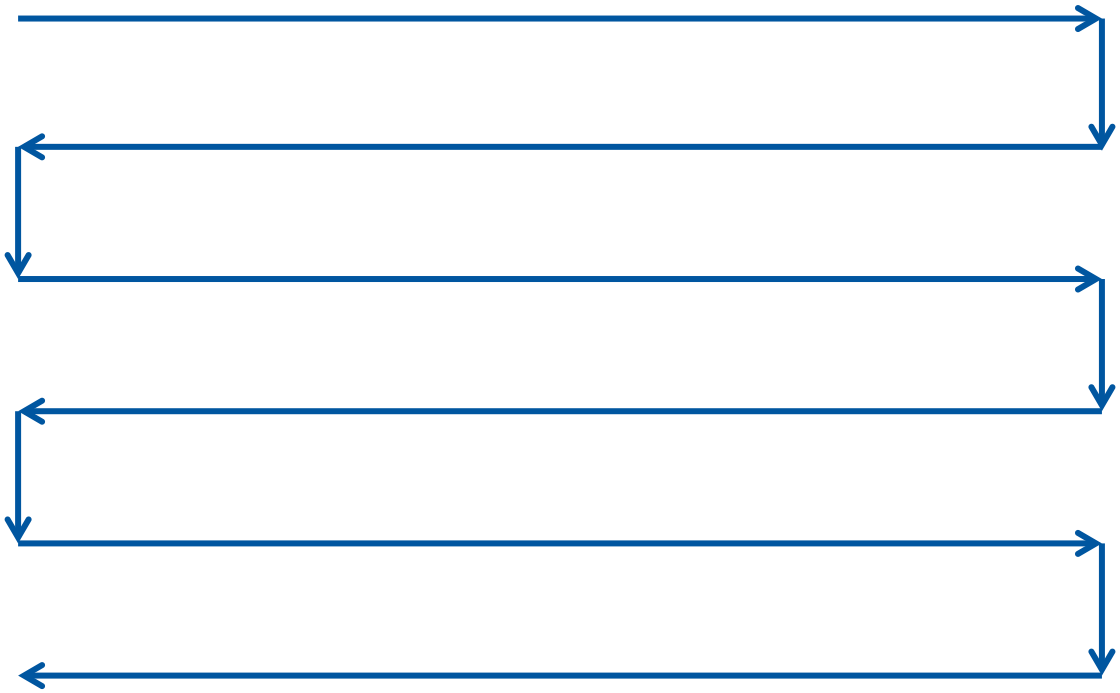


Beam Expander Systems II: 1D Rastering

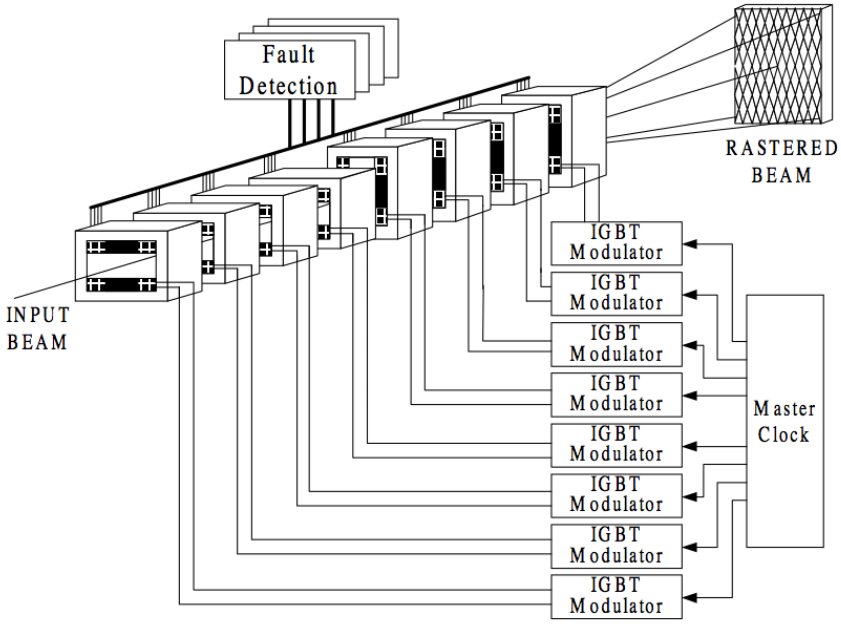


Beam Expander Systems II: 2D Rastering

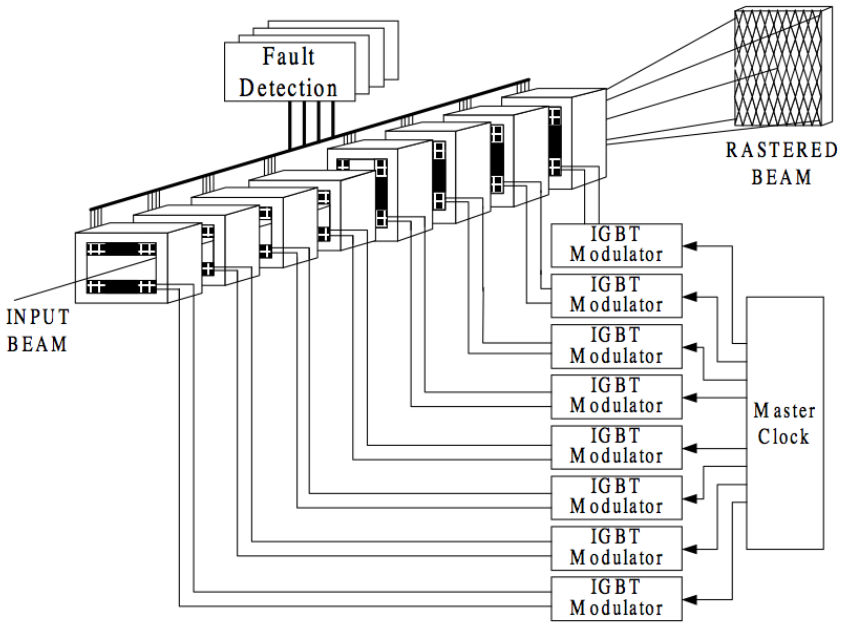
Traditionally: Hor. MPS: Slow
Ver. MPS: Fast



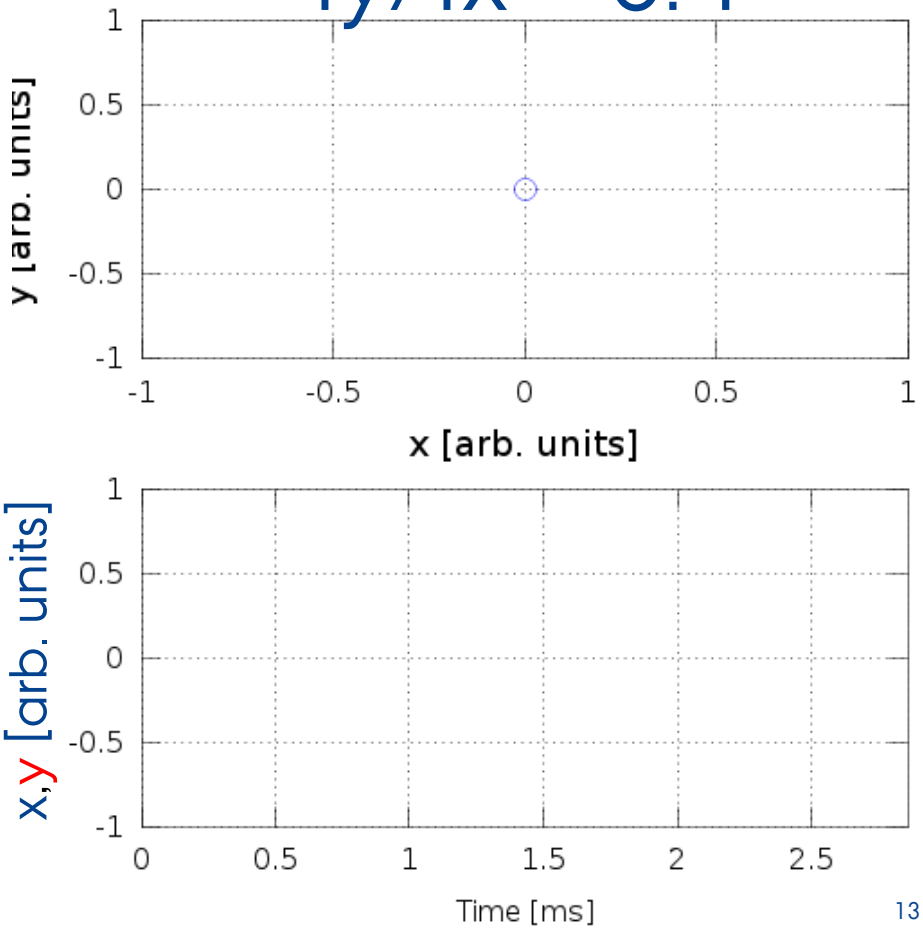
Beam Expander Systems II: 2D Rastering



Beam Expander Systems II: LANL APT

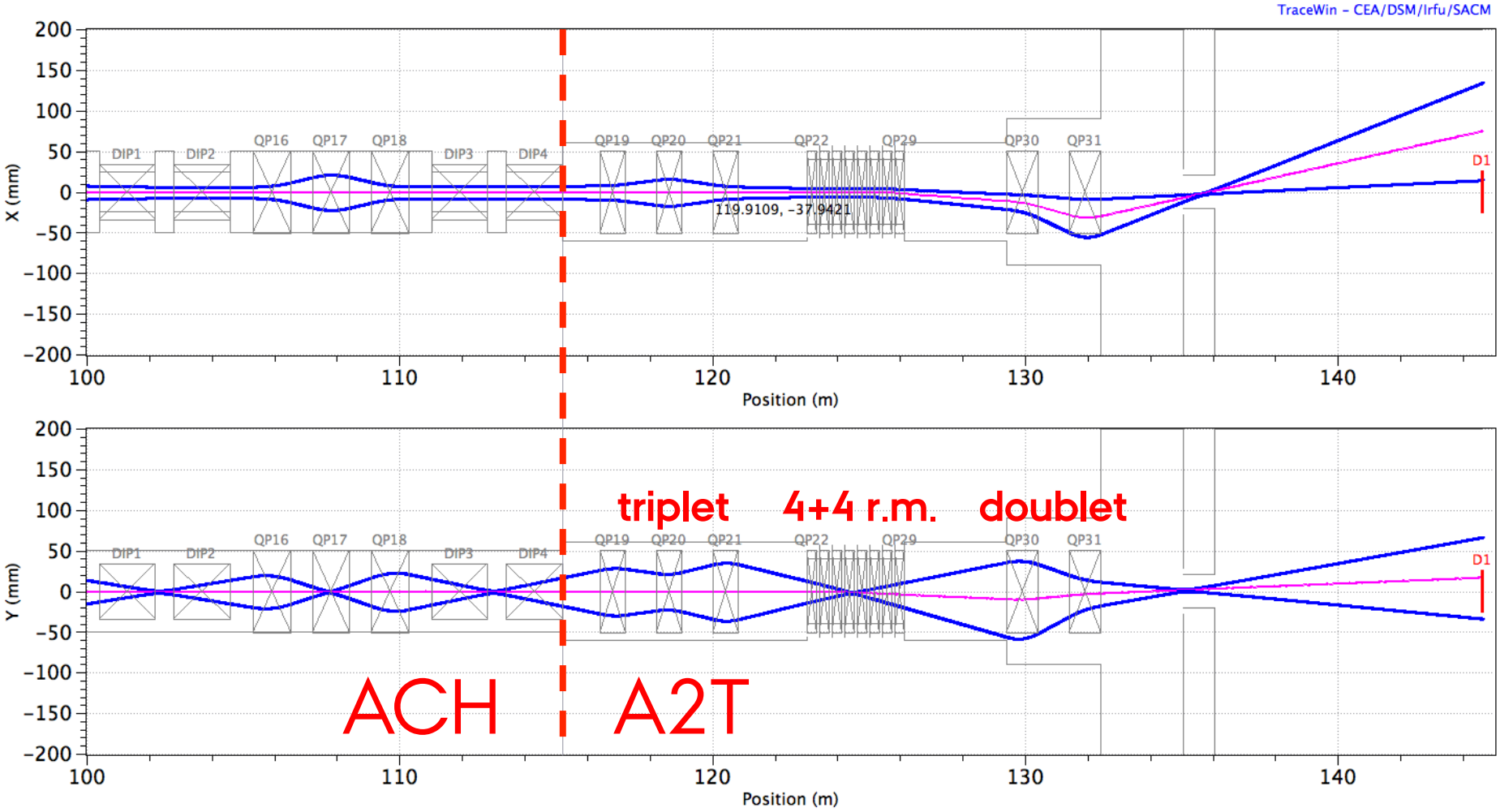


fy/fx = 5:4

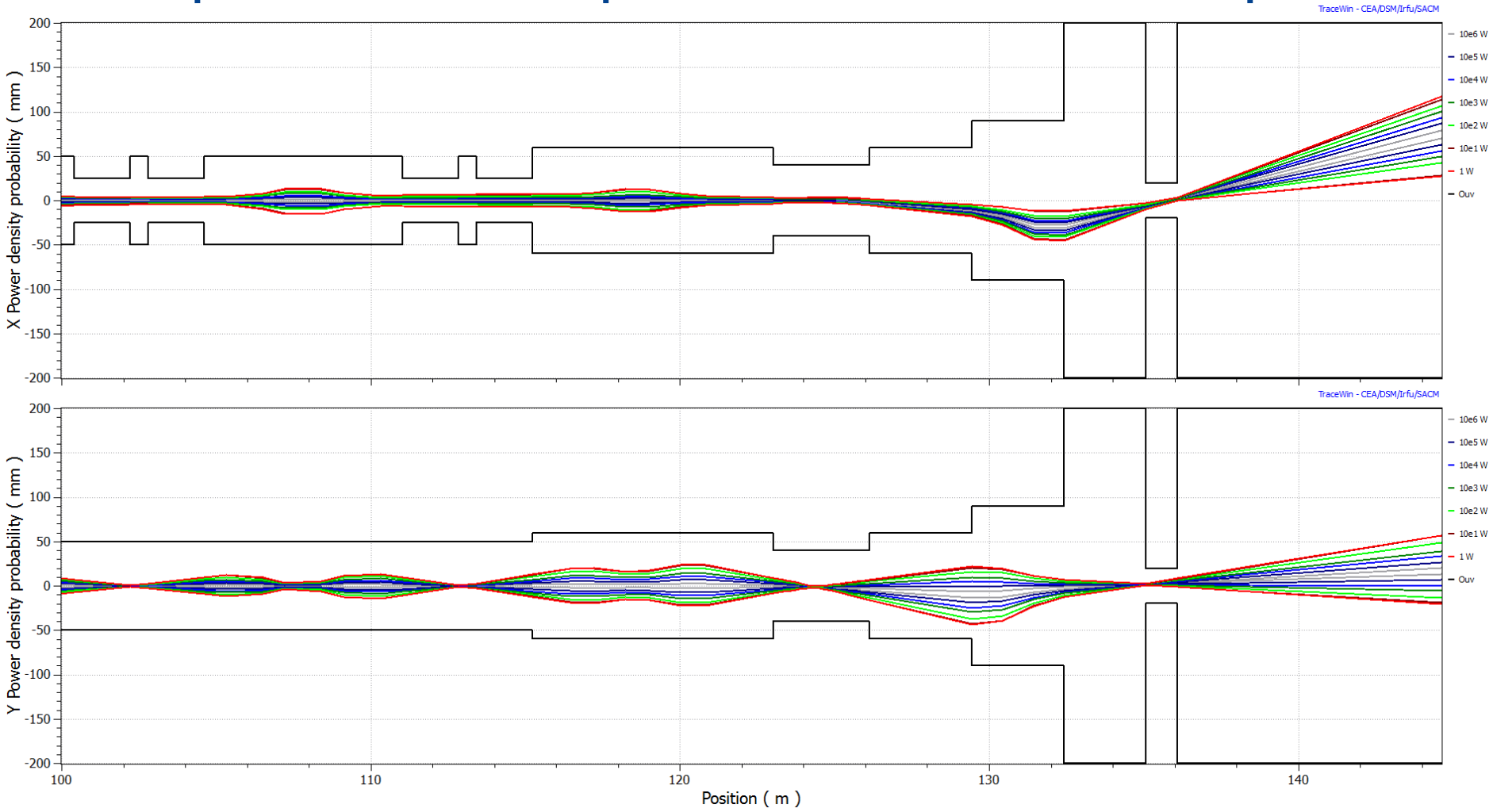


One ESS pulse

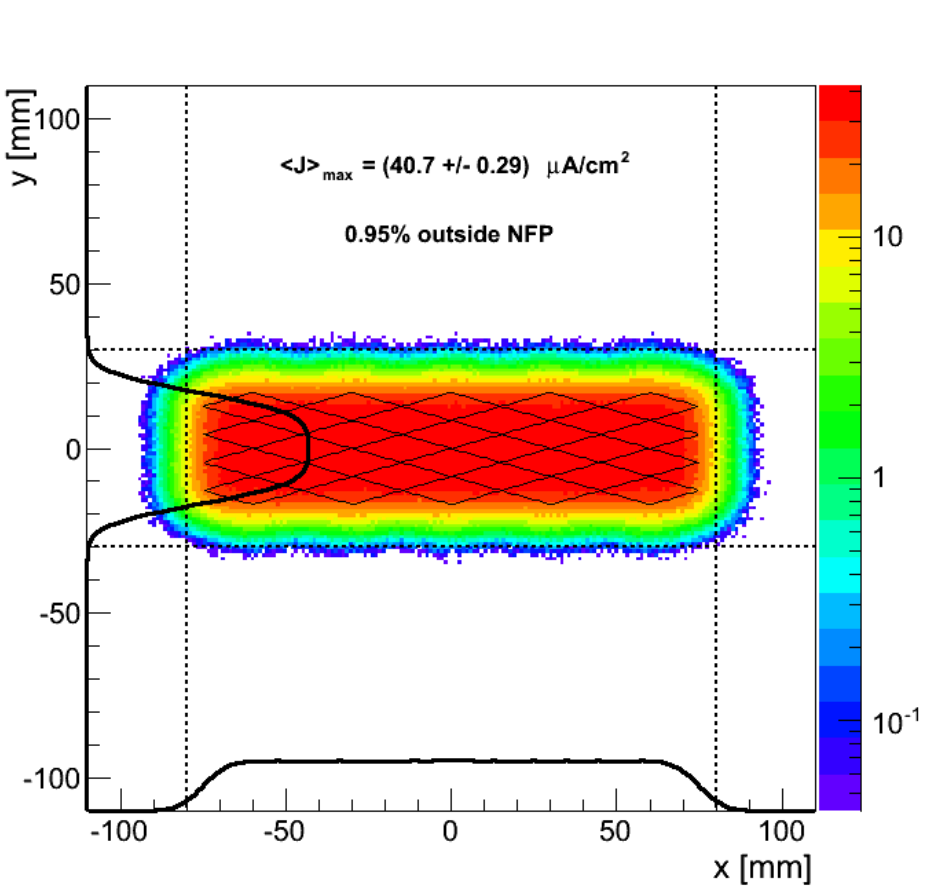
Linear optics: 10 RMS beam size



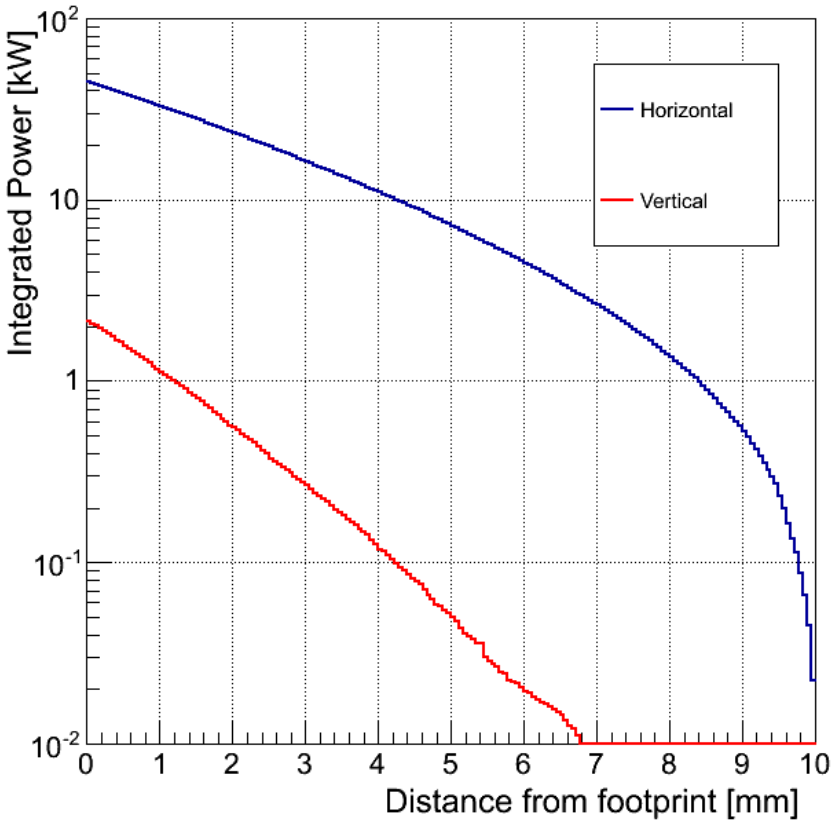
Multiparticle: 1 Mparticles of SCL output



Monte Carlo Simulation: 5:4 pattern



(45 + 2.2) kW ~ 0.95% outside NFP



10 Mparticles - time-lapse:

http://users-phys.au.dk/heinetho/raster_anim_MC.gif

Choice of frequencies?

- f0 = 1 / Δt = 350 Hz
- fx = nx × f0
- fy = ny × f0

- Frequency stability
- Modest phase stability

Conditions:

1) nx, ny are integers
2) nx/ny as irrational as possible?
3) Intensity modulations at instruments?

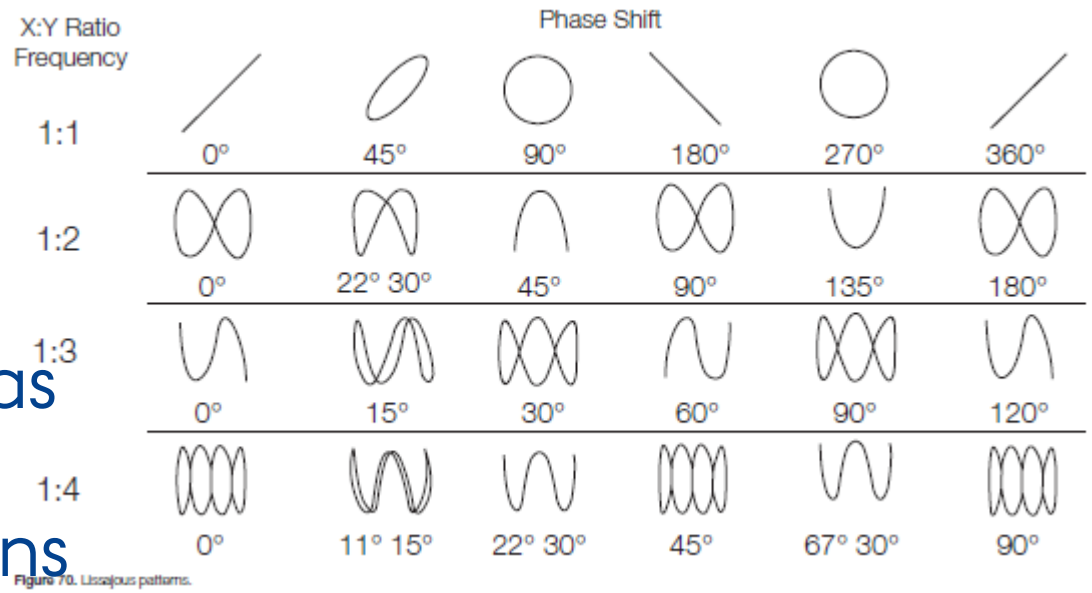


Figure 70. Lissajous patterns.

High Frequencies?

Existing Systems

- J-LAB:
  - B = 40 G, L =15 cm
  - f = 10-45 kHz
  - Air-coils of Litz-wire
  - H-bridge of MOSFETs
- LANL APT (1.7 GeV, 100 mA):
  - B = 500 G, L = 4 x 30 cm
  - f = 0.5-0.6 kHz
  - Ferrite-based magnets
  - H-bridge of IGBTs
- LANL MTS:
  - f = (20 + 60) kHz (sinus.)

ESS?

- B = 250 G, L = 4 x 30 cm?
- f = 5-20 kHz? (TD + Science)
- Air-coils?

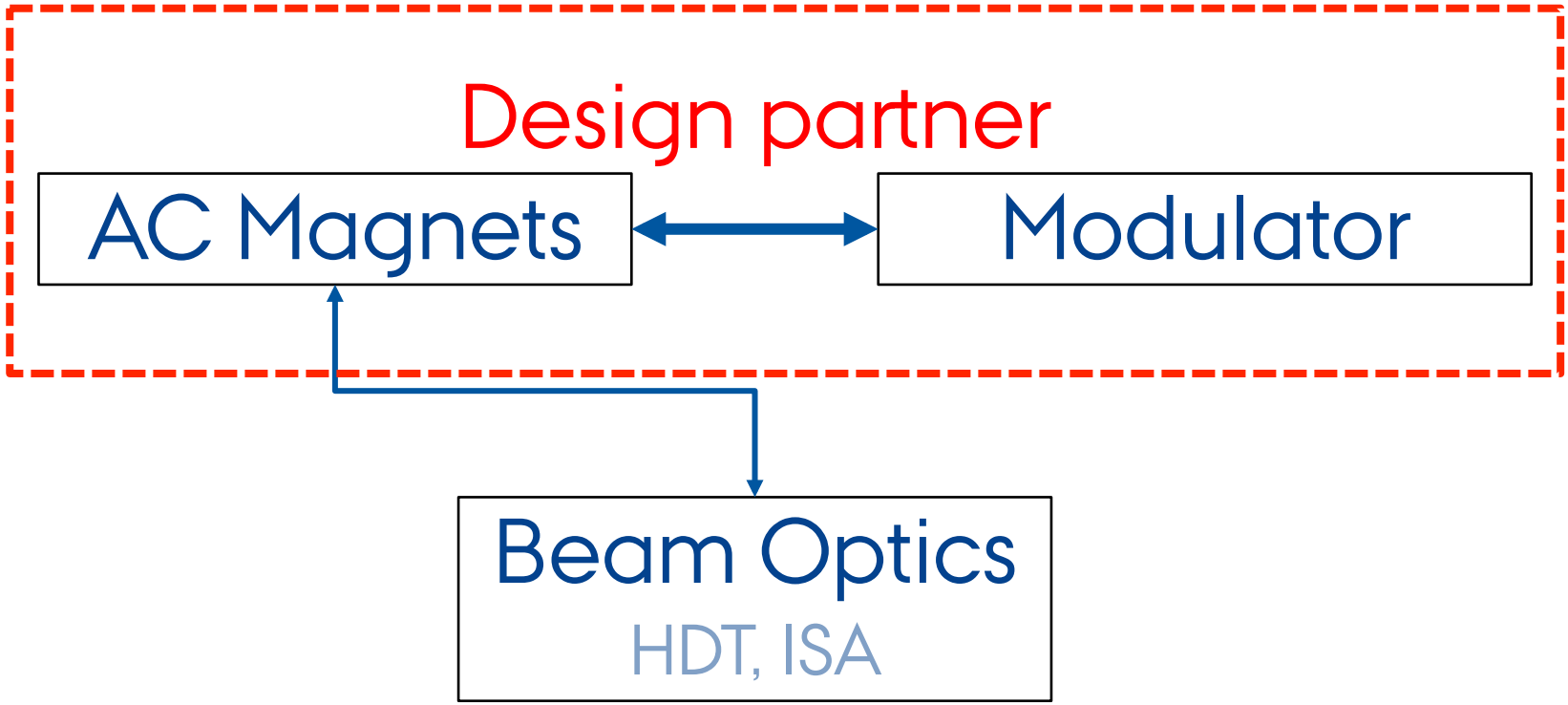
ESS Lissajous System

- Linear optics!
- All feasible magnetic elements
- Losses: 0 / 10^6 particles!

Choice of frequency set?

- Neutron yield modulation at instruments?
- Target stress & fatigue?
- …

Development of the Lissajous System



2013.06: CDR for Lissajous system
2013.10: Comparison of beam expanders
2014: TDR + prototype